

REMARKS

Claims 15 and 35 are amended. Claims 15-22 and 35-41 are pending in the application.

Claims 15-22 and 35-41 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. The Examiner indicates that the claims contain subject matter which was not described in the specification sufficiently to convey that the inventors had possession of the claimed invention at the time the application was filed. The Examiner states that the recited “utilizing an oxygen plasma to entirely remove a residue” (claims 15 and 35) is not supported by the specification. Without admission as to the propriety of the Examiner’s rejection, claims 15 and 35 are amended to delete the term “entirely”. Accordingly, applicant requests withdrawal of the § 112, first paragraph, rejection of claims 35 and 15 and their dependent claims in the Examiner’s next action.

Claims 15-22 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Examiner indicates that the claim 15 recited “gas consisting of one or more members of the group consisting of O₂, O₃, H₂ and NH₃” renders the claim indefinite because it is unclear as to how oxygen-comprising plasma can be generated from hydrogen gas alone. Without admission as to the propriety of the Examiner’s rejection, claim 15 is amended for clarification to recite a gas having active components consisting of one or more members of the group consisting of O₂ and O₃, and optionally one or both of H₂ and NH₃. Accordingly, applicant respectfully requests

withdrawal of the § 112, second paragraph, rejection of independent claim 15 and its dependent claims in the Examiner's next action.

Claims 15-22 and 35-41 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over various cited combinations of Mathews (U.S. Patent No. 5,658,829), Allen (U.S. Patent No. 5,970,373), Sharan (U.S. Patent No. 5,747,116), Brown (U.S. Patent No. 5,780,359), and Nagashima (U.S. Patent No. 5,129,958). The Examiner is reminded by direction to MPEP § 2143 that a proper obviousness rejection has the following three requirements: 1) there must be some suggestion or motivation to modify or combine reference teachings; 2) there must be a reasonable expectation of success; and 3) the combined references must teach or suggest all of the claim limitations. Claims 15-22 and 35-41 are allowable over Mathews, Allen, Sharan, Brown and Nagashima for at least the reason that the references, individually or as combined, fail to disclose or suggest each and every element in any of those claims, fail to provide a reasonable expectation of success, and fail to provide motivation for combination. Accordingly, a *prima facie* case of obviousness has not been established.

Independent claim 15 recites etching material beneath a masking layer to outwardly expose a conductive silicon-comprising material at a base of an opening, removing a masking layer from the substrate, and subsequently utilizing an oxygen-comprising plasma to remove a residue from the outwardly exposed conductive silicon-comprising material, where the plasma is generated from a gas having active components consisting of one or more of O₂ and O₃, and optionally one or both of H₂ and NH₃. Mathews discloses etching BPSG to form a contact opening utilizing a dry etch with argon to minimize polymer buildup during the etch process (col. 3, ll. 38-42). Mathews additionally discloses subsequent

removal of masking layer 42 (col. 3, ll. 43-44). Such disclosure does not teach or suggest the claim 15 recited etching to expose a conductive silicon-comprising material followed by removal of a masking layer and subsequent utilization of an oxygen-comprising plasma to remove residue from the outwardly exposed conductive silicon-comprising material. Nor does the use of argon during dry etch to minimize polymer buildup during the etch process as disclosed by Mathews provide motivation to perform a post etch plasma removal of residue as recited in claim 15.

At page 5 of the present Action the Examiner indicates reliance upon Allen as disclosing use of an oxygen-comprising plasma for removing residual matter. However, as acknowledged by the Examiner, Allen specifically indicates using such oxygen-comprising plasma for removal of residue from a dielectric (nitride) material. Allen does not disclose or suggest the claim 15 recited removal of residue from an outwardly exposed conductive silicon-comprising material. Further, a problem specifically addressed by the present invention is to remove residue from a conductive base surface after formation of a contact opening. Neither of Mathews or Allen addresses this issue. Nor does the Allen disclosure of removing residue from a nitride material provide a basis for a reasonable expectation of achieving the claim 15 recited removal of residue from an outwardly exposed conductive material using a plasma generated from a gas having active components consisting of one or more members of O₂ and O₃ and optionally one or both of H₂ and NH₃. Accordingly, in combination Allen and Mathews fail to disclose each and every element of claim 15, fail to provide a reasonable expectation of success and additionally fail to provide motivation for combination.

At pages 6-7 of the present Action the Examiner indicates reliance upon Sharan as disclosing exposing monocrystalline silicon and removal of an unwanted material utilizing hydrogen plasma. However, the hydrogen plasma disclosed by Sharan does not teach, suggest or contribute towards suggesting the oxygen-comprising plasma recited in claim 15. Further, the Sharan disclosure indicates removal of an oxide material and does not address the problem addressed by claim 15. Accordingly, as combined with Mathews and Allan, Sharan does not provide motivation for combination or provide a basis for a reasonable expectation of achieving the claim 15 recited removal of residue from an outwardly exposed conductive silicon-comprising material using an oxygen-comprising plasma. Accordingly, independent claim 15 is not rendered obvious by the combination of Allen, Mathews and Sharan.

At page 7 of the present Action the Examiner indicates reliance upon Brown as disclosing a stripping process conducted at a temperature ranging between 20° to over 100°C with benefits of using higher temperatures. At page 8 of the present Action the Examiner indicates reliance upon Nagashima as disclosing use of ammonia and hydrogen as reducing gas for cleaning a residue, however, Brown discloses appropriate temperatures for post metal-etch processing and Nagashima discloses reducing gases for utilization during cleaning of wafer processing chambers. Neither of these disclosures contributes toward suggesting the claim 15 recited post etch utilization of an oxygen-comprising plasma to remove residue from an outwardly exposed conductive silicon-comprising material where the plasma is generated from a gas having active components consisting of one or more of O₂ and O₃ and optionally one or both of H₂ and NH₃. Nor does either of Nagashima and Brown address the issue of residue removal after formation of a

contact opening. Accordingly, such do not provide motivation for combination. Nor do the disclosed temperature and reducing gases in the context disclosed contribute toward providing a reasonable expectation of achieving the recited removal of residue from an outwardly exposed conductive silicon-comprising material. Therefore, the combination of Nagashima, Brown, Mathews, Allen and Sharan fails to disclose or suggest each and every element in independent claim 15, fails to provide a reasonable expectation of success, and fails to provide motivation for combination. A *prima facie* case of obviousness has not been established by the various cited combinations of Mathews, Allen, Sharan, Brown and Nagashima. Claim 15 is therefore allowable over the cited references.

Dependent claims 16-22 are allowable over the various cited combinations of Mathews, Allen, Sharan, Brown and Nagashima for at least the reason that they depend from allowable base claim 15.

Independent claim 35 recites dry etching a layer of BPSG to expose a monocrystalline silicon substrate material at a base surface of an opening, and forming a carbon-containing polymer residue at least partially over the substrate material at the base of the opening. Claim 35 additionally recites removing the photoresist layer and subsequently plasma etching to remove the carbon-containing polymer residue substantially selectively relative to BPSG and relative to the monocrystalline silicon substrate material using a plasma generated from one or more of O₂, O₃, H₂ and NH₃. As indicated above, Mathews does not disclose or suggest forming an opening and subsequently removing residue from a base surface of the opening. As further indicated, Mathews specifically indicates minimizing polymer buildup during formation of a contact

opening and therefore does not provide motivation for the claim 35 recited post etch residue removal processing.

The Allen disclosure specifically indicates removal of residue from over a dielectric material. Accordingly, such does not disclose or suggest the recited removal from monocrystalline silicon substrate material. Further, since Allen does not disclose or suggest the recited removal of carbon-containing polymer residue from a monocrystalline silicon substrate material as specifically recited in claim 35, Allen cannot suggest the recited removal being substantially selective relative to BPSG or substantially selective relative to the monocrystalline substrate material. Additionally, not one of Sharan, Brown or Nagashima contribute toward suggesting the claim 35 recited removal of carbon-containing polymer residue from a monocrystalline silicon substrate where the removal is substantially selective relative to BPSG layer and relative to the monocrystalline silicon substrate material. Nor does any of the references address the problem of post etch residue removal from a monocrystalline silicon substrate material where the residue material is removed substantially selectively relative to BPSG and monocrystalline silicon material. Accordingly, the references fail to provide motivation for combination. Additionally, as discussed above with respect to claim 15 the combination of Mathews, Allen, Sharan, Brown and Nagashima fail to provide a reasonable expectation of successful removal of carbon-containing polymer residue from a monocrystalline silicon substrate material, and also fails to provide a reasonable expectation of substantial selectivity as recited in claim 35. Therefore, claim 35 is not rendered obvious by the various cited combinations of Mathews, Allen, Sharan, Brown and Nagashima and is allowable over these references.

Dependent claims 36-41 are allowable over the various cited combinations of Mathews, Allen, Sharan, Brown and Nagashima for at least the reason that they depend from allowable base claim 35.

Claims 15, 17-18, 22, 35-36 and 39-40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mathews as combined with Kuhman (U.S. Patent No. 5,900,288).

As discussed above, Mathews fails to disclose or suggest the claim 15 recited utilization of an oxygen comprising plasma after formation of an opening to expose a conductive silicon-comprising material to remove a residue from the outwardly exposed conductive silicon-comprising material. The Examiner indicates at page 9 of the present action that Kuhman is relied upon as disclosing a hydrogen plasma for removing residual matter. However, claim 15 specifically recites utilizing an oxygen-comprising plasma. Kuhman does not disclose or suggest utilizing the claim 15 recited oxygen-comprising plasma. As combined, Kuhman and Mathews fail to disclose or suggest the claim 15 recited oxygen-comprising plasma. Further, the Kuhman disclosure does not address the problem overcome by independent claim 15 where residual material on an outwardly exposed conductive silicon-comprising material is removed by plasma after forming an opening to outwardly expose a conductive silicon-comprising material at the base of an opening. Accordingly, the combination of Kuhman and Mathews fails to provide motivation for combination. Nor does the combination of Mathews and Kuhman provide a reasonable expectation of achieving the claim 15 recited removal of residue from over an exposed conductive silicon-comprising material utilizing an oxygen-comprising plasma. Accordingly, claim 15 is not rendered obvious by the combination of Kuhman and Mathews and is allowable over these references.

Dependent claims 17, 18 and 22 are allowable over Mathews and Kuhman for at least the reason that they depend from allowable base claim 15.

As discussed above, independent claim 35 specifically recites forming an opening and subsequently using a plasma to selectively remove residue relative to BPSG and relative to a monocrystalline silicon substrate material. Mathews fails to disclose or suggest any post etch residue removal. Kuhman discloses utilizing a hydrogen plasma to clean a substrate of a thermal inkjet device. However, such teaching does not disclose or suggest the claim 35 recited selective removal of residue from a monocrystalline substrate material with selectivity relative to BPSG and relative to the monocrystalline silicon substrate material. Accordingly, independent claim 35 is not rendered obvious by the cited combination of Kuhman and Mathews.

Dependent claims 36 and 39-40 are allowable over Kuhman and Mathews for at least the reason that they depend from allowable base claim 35.

For the reasons discussed above, claims 15-22 and 35-41 are allowable. Accordingly, applicant respectfully requests formal allowance of such claims in the Examiner's next action.

Respectfully submitted,

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